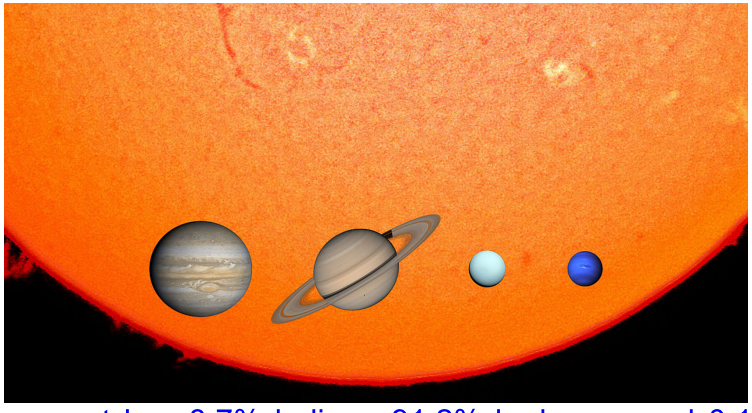
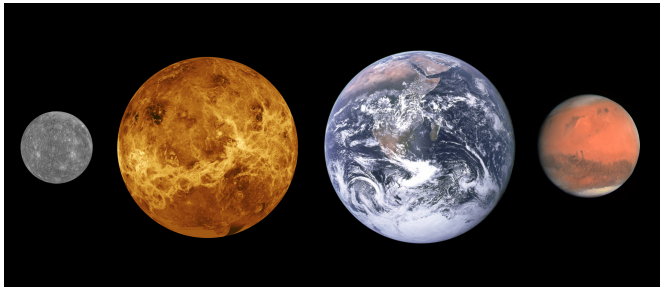


We learnt that the solar system was formed due to gravitational attraction in interstellar matter about 4.5 billion years ago. Inside the sun, hydrogen is continuously converted into helium and other elements. Some matter is converted into energy which makes the sun self luminous. We also learnt that planets though initially quite hot have cooled and can only be seen by reflected sunlight. The sun at present has 8.7% helium, 91.2% hydrogen and 0.1% other elements. Experiments show that elements are not found in the same concentrations in the planets. Jupiter, Saturn, Uranus and Neptune are called the gas giants. They are much heavier than the earth, mostly made of gases and the ratio of hydrogen to helium is approximately the same as in the sun. {Picture above} The ratios of helium and hydrogen are 10:90 in Jupiter, 10 : 90 in Saturn, 15:83 in Uranus and 19:80 in Neptune. Percentage of all other elements is small but since the planets are huge, there will be large quantities of other elements. Scientists find that these four planets also have a core which is partly liquid and partly solid. The temperature of the core is more than 30,000^{o}C.

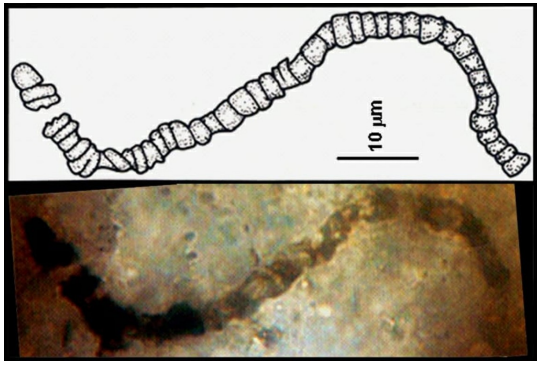
These gas giants are completely different from the inner planets of the solar system, Mercury, Venus, Earth and Mars. These four are solid planets. None of them have hydrogen or helium in gas form. The smallest of these, Mercury has no atmosphere at all. Mars has a very thin atmosphere, roughly 1% of the earth's atmosphere at sea level.



Venus is about the same size as the Earth. {Picture Right} The atmospheric pressure of Venus is 90 times higher. Mars is roughly half the size of Venus but in both, the ratio of carbon dioxide to nitrogen present in the atmosphere is roughly the same. On Mars 95% of the atmosphere is nitrogen. 2.7% is carbon dioxide. On Venus the ratio is 96.5 : 3.5. These small differences can be explained with the help of physics. But why does the earth have 21% Oxygen and 78% Nitrogen? The answer to this big question cannot be provided by physics.

All bodies at the same temperature have the same thermal energy. In gases, the thermal energy is their kinetic energy. Gases with lower molecular weight have higher average velocities. If two gases are at the same temperature and the molecular weight of one is half the molecular weight of the other, it's average velocity is four times the average velocity of the other gas. Molecular weight of hydrogen and helium are the lowest among all elements. So their average velocities will be much higher. Small planets have low gravitational force and cannot prevent hydrogen and helium from escaping into space. The smaller planets are all closer to the sun. They move much faster and have higher average temperatures. Because of these reasons the compositions of planets are different. Mercury, the smallest planet, closest to the sun and the hottest has no atmosphere at all.

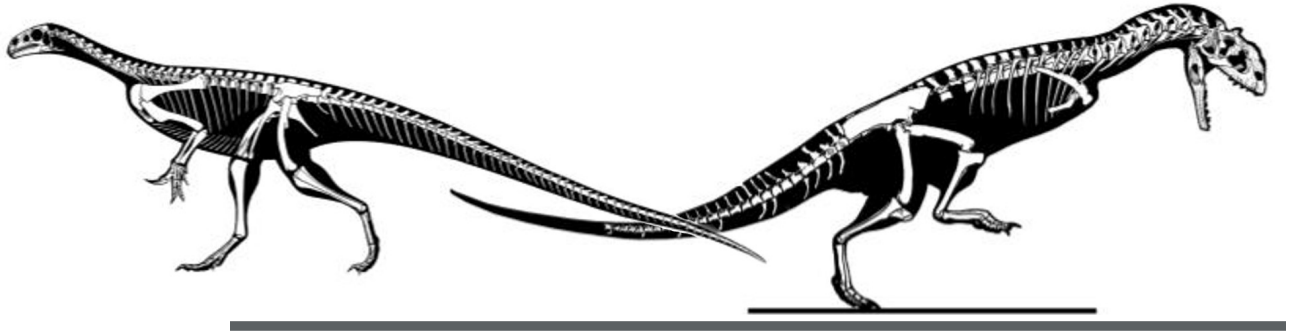
Earth has free oxygen in its atmosphere because there is life on earth. Fossils show {Picture top opposite page} that living beings existed on earth for more than 3.5 billion



years. About 2.4 billion years ago cyanobacteria evolved. These were the first life forms that could use sunlight to prepare food. Plants evolved from cyanobacteria. Oxygen is released when the carbon dioxide and water react to form glucose. Initially, the free oxygen reacted with the soluble metal salts in water and formed oxides which are not soluble. The oxides accumulated as layers at the bottom of the water. That is the reason the ores of most metals used by humans are oxides. Even today, orange colored layers of iron oxide can be seen in mines. {Picture left} About 400 million years ago, most metal ions that could form insoluble oxides were exhausted. Today in the oceans there are only compounds of metals like sodium. The oxides of these metals are soluble in water. When oxygen could not be deposited as oxides, free oxygen being released by the cyanobacteria started to collect in the atmosphere. Soon life forms that could use the atmospheric oxygen and live on land evolved. About 300 to 360 million years ago the earth was covered with huge forests. The oxygen concentration increased to about 30%. Those trees formed the coal that we use today. Images of the trees of that era can be occasionally seen in coal mines. {Picture right} Similarly, ancient sea shells formed the chalk and

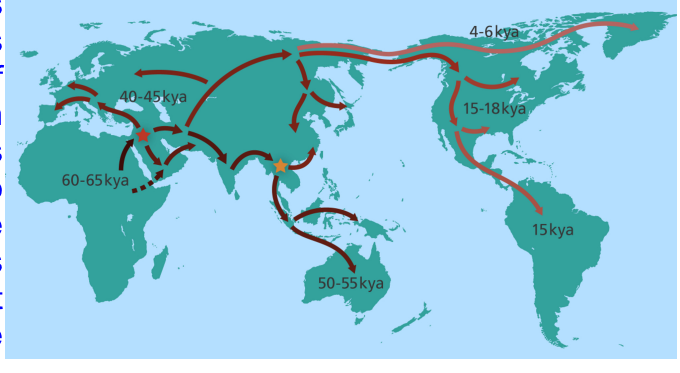
limestone of today. {Picture on next page} Petroleum has also formed from microorganisms that have died long ago. The coal used to convert iron ore into steel and make chisels as well as the marble from which beautiful statues are carved are all products of ancient life.

Darwinian evolution requires enormous time. Given time large changes can take place. As an example consider dinosaurs. Fossils show that the earliest dinosaurs existed 250 million years ago and that they became extinct about 60 million years ago. The smallest dinosaur is Compsognathus. It was the size of a chicken. In contrast, Argentinosaurus, the largest known dinosaur, was as heavy as ten to twenty elephants. One of the earliest, Thecodontosaurus was a 1 to 2 m long vegetarian while one of the last dinosaurs to live, Manjugathorus was a meat eater that grew to a length of 6 to 7 m. {Picture below} Even very small evolutionary changes

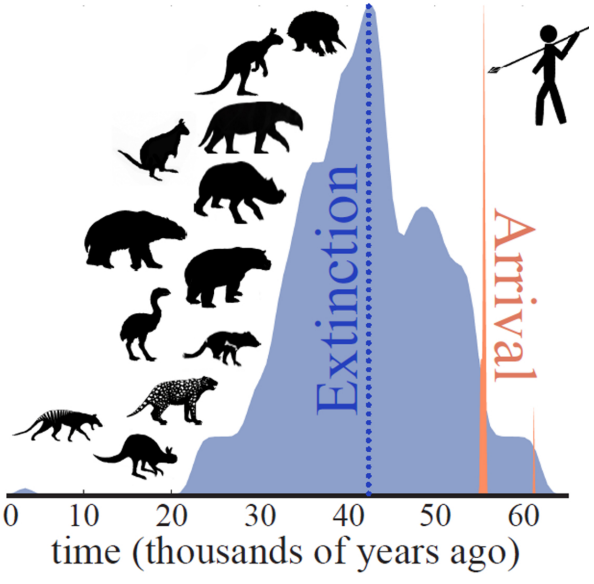


take enormous time. For example, the Royal Bengal tiger, used to the marshy tropical climate near the tropic of cancer changed slightly and became the Siberian tiger {Picture above} which lives in deep snow and ice. According to scientists, this change took several hundred thousand years.

Modern humans evolved in the grasslands of Africa 60 to 100,000 years ago. This is confirmed by archaeology and the study of genes. But forty thousand year old human remains are seen in all continents. That is to say, it took humans merely twenty to thirty thousand years to get used to the various climatic conditions in the various continents; {Picture right} icy Arctic, the hot and humid equatorial jungles as well as the



deserts. They could cross the oceans to reach Australia and live on the high Andes of South America. And humans at that era had little more than stone tools and perhaps the ability to start a fire. Not only this, wherever the ancient humans went, they caused the extinction of a very large number of large animals. {Picture right} Animals that coexisted for million years or more with other animals became extinct. And the time of their extinction coincided with the entry of humans. There is no doubt that they could not coexist with humans. And the humans had no guns; not even bows and arrows.



Two things are very clear. Humans evolved just like all other animals, by a process of Darwinian evolution. But there is a very large gap between humans and all other living beings. To show the feedback loops in the environment and claim that nature is itself a life form Gaia is unscientific. But the earth did undergo fundamental changes because of life.